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EDITORIAL

Barcelona Longitudinal Growth Study 1995–2017☆

Estudio Longitudinal de Crecimiento Barcelona 1995–2017

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The Barcelona Longitudinal Growth Study 1995–2017 represents a significant contribution that may help modify our clinical approach to the assessment of pubertal growth, malnutrition and obesity in childhood and adolescence.

For the first time, five pubertal growth patterns are reported according to age at onset of the pubertal growth spurt (PGS), with over 100 girls/boys in each pattern. These patterns will contribute to a better clinical assessment of pubertal growth by avoiding the errors made when only a single pattern is used, particularly with very early and very late maturing individuals. Such errors can lead to misdiagnoses, unnecessary treatments and distress in both the child and the family.

Body mass index (BMI)/age (birth–adult height) patterns are also reported for the first time in a non-obese and non-malnourished pediatric population. These patterns are not biased by the inclusion of an indeterminate number of overweight and/or obese girls/boys, as occurs with the currently used patterns.

In this Editorial we discuss the relevant aspects of the study, including data on height, the growth rate, weight and the body mass index from birth to adult height in 1453 healthy and non-obese subjects (743 females and 710 males). Readers can consult the website[1] and publications[2,3] for further information that may prove useful in their daily clinical practice.

The anthropometric assessment of growth is a biological marker of the health status of each child and the wellbeing of the society to which he/she belongs, with length/height, the growth rate, weight and the BMI being the most widely used parameters.

There has always been great interest in conducting growth studies in Spain. Among such studies, mention can be made of the cross-sectional surveys between 2000 and 2005 (in Andalusia, Barcelona, Bilbao, Madrid and Zaragoza) and the longitudinal studies between 1978 and 2000 (in Barcelona, Bilbao, and Zaragoza) published as Spanish Growth Studies 2010[4].

The greatest inter-annual growth rate is seen during the first year of life, followed by a gradual decrease up until the start of pubertal development. At this point, progressive acceleration or the pubertal growth spurt (PGS) occurs over the next two years until the peak of pubertal growth is reached. This in turn is followed by a deceleration of variable duration (3–4 years) to zero, when growth ends and adult height is reached. The start of the PGS represents an objective and clearly identifiable piece of information

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for calculating inter-annual growth rates that sharply differentiates prepubertal growth from pubertal growth and represents the anthropometric marker for the start of pubertal development.

Each girl/boy has her/his own maturating ''tempo'' for starting puberty. The onset of the PGS is continuous for a period of time from 8 to 13 years of age in girls and from 10 to 15 years of age in boys. This variability implies that only longitudinal studies are able to adequately assess pubertal growth. Cross-sectional studies are useful for evaluating prepubertal growth at ages when girls and boys have not yet started pubertal development (girls < 8 years of age, boys < 10 years of age) and for establishing adult height.

Age at onset of the PGS conditions the intensity and duration of pubertal growth and for the clinical assessment of pubertal growth it is necessary to consider several reference patterns. This is in contrast to what occurs in the prepubertal period, when a single pattern is used for each gender. Girls/boys with similar prepubertal growth (height in cm) may exhibit wide differences in pubertal growth when the latter starts at different ages, even when their adult heights end up being the same. Those starting puberty early grow earlier and more intensely than those starting puberty later. However, the latter start the PGS with greater height, and although their pubertal growth (height gain in cm) is lower, they all will eventually have similar adult heights, as occurred during the prepubertal phase.

It was Tanner who, in a longitudinal growth study conducted in 1976, pointed out this fact, plotting graphs widely shaded to mark the variability and intensity of pubertal growth according to age at onset of the PGS.[5] In 2005, Ángel Ferrández[6] proposed five pubertal growth patterns at one-year intervals: very early, early, intermediate, late and very late maturing subjects. Subsequently, the longitudinal growth study 1978–2000, involving a larger number of girls/boys, showed that each of these five groups had a pubertal growth pattern different from those of the other four.[7,8] However, due to the limited number of individuals evaluated, these data required confirmation with a greater sample of subjects.

The Barcelona Longitudinal Growth Study 1995–2017 confirms the previous data, affording differentiated patterns for each of the 5 pubertal maturing groups, with more than 100 girls/boys in each group. The characteristics of the evaluated sample, the methodology used and the results obtained have been published[2,3] and can be found on the bilingual Spanish/English website, www.millennialsgrowth.com

For each gender, for each of the five pubertal maturing groups, and for the whole population, data are provided on height, the inter-annual growth rate, weight and the body mass index in the form of tables and graphs expressed as percentiles and as means and standard deviations (SD), along with ages at menarche and height gain from menarche to adult height.

It should be noted that for each gender, height values at prepubertal ages and in adulthood are similar to those obtained in other recent cross-sectional studies of Spanish, European and American populations. The five pubertal growth patterns may therefore also be used to assess pubertal growth in these populations.[2]

The question of which BMI/age patterns should be used as references for defining the degree of malnutrition, overweight and obesity during childhood and adolescence remains a subject to debate. In this regard, the need for patterns obtained from current populations without malnutrition or obesity needs emphasis, since the currently used patterns are biased by the inclusion of a variable proportion of overweight and/or obese girls/boys, or come from studies conducted during the last century.[9–15]

The Barcelona Longitudinal Growth Study 1995–2017 for the first time provides values of BMI/age (birth–adult height) corresponding to a non-obese and non-malnourished population in both genders. A single pattern including the data from the entire population may be used as a reference for each gender, since there are no clinically relevant differences between the five pubertal maturing groups and the population as a whole. Even the differences between the genders are likewise of scant clinical relevance. These observations are due to the fact that the weight/age increments in each girl/boy are proportional to those of height/age, and are the consequence of obese or malnourished children not being included in this study.

The mean BMI/age values in each gender are similar to those proposed by the World Health Organization (WHO). However, the cut-off point used to define obesity (+2 SD) differs, and the same occurs with the cut-off points proposed by Cole, the Bilbao study 88, and the Spanish cross-sectional growth study 2010.[1,3,4,9,12–15] In the WHO study, the BMI/age values do not exhibit a normal distribution. Consequently, the value of a SD gradually increases as we shift from 0 SD to + 1 SD, from + 1 SD to + 2 SD, and from + 2 SD to + 3SD. By comparison, in the Barcelona 1995–2017 study, since obese or malnourished subjects were not included, the distribution of these values is virtually normal, and the value of a SD is always the same.

Epidemiologically, Cole and the WHO proposed cut-off values for BMI/age to define malnutrition, overweight and obesity.[12–15] However, clinically it is of interest to know the degree of obesity, as it is related to the complications of obesity.[16,17] Stratifying the degree of obesity with BMI/age patterns obtained in non-obese and non-malnourished populations, where the distribution is practically normal and the SD values are constant, representing a methodological and practical advantage as compared to using SD values from populations in which the BMI/age values do not show a normal distribution, and the SD values are modified for each degree of obesity. Moreover, using such SD values would be clinically very complex.

The website www.millennialsgrowth.com[1] also includes data on the growth of preterm and term newborn infants (gestational age 26–42 weeks) and on children born in Spain of immigrant populations.

Applications for mobile phones and tablets (Android and iOs), software (PC MS Windows) for anthropometric calculations, and all growth tables and graphs can be downloaded free of charge from this website.

Conflicts of interest

None

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